TCEC13: the 13th Top Chess Engine Championship

TCEC13: the 13th Top Chess Engine Championship

Guy Haworth and Nelson Hernandez[1]
Reading, UK and Maryland, USA

After the successes of TCEC Season 12 (Haworth and Hernandez, 2019a), the Top Chess Engine Championship moved straight on to Season 13, starting August 3rd 2018 with the same divisional structure as for Seasons 11 and 12.

Five divisions, each of eight engines as in Fig. 1 and Table 1, played two or more 'DRR' double-round-robin phases with promotions and relegations following. Classic tempi gradually lengthened and the Premier division's top two engines played a 100-game match to determine the Grand Champion.

Fig. 1. Logos for the TCEC 13 engines as in their original divisions.

The formidable 44-core server of TCEC11-12 (Intel, 2017) was joined by a second server sporting two Nvidia GeForce GTX 1080 Ti GPUs (Nvidia, 2018) to provide better support for two engines, LC0 and DEUS X which both exploited LC0's 'NN' neural network architecture. IVANHOE and CHESS22K were also new to TCEC while FRUIT chose to step away from the action this time. The tie-break sequence was changed to 'number of disconnects', 'head-to-head results', wins, 0-1 wins, Sonneborn-Berger score. Given CHIRON's and others' technical failure in Season 12, and the added risk factors associated with the more complex common platform, the rules for modifying engines were redefined to include mandatory scaling-down and one repair of engines between the games of a division.

[1] Corresponding author: g.haworth@reading.ac.uk

Table 1. The TCEC13 engines (CPW, 2018), details, authors and progress.

#	αβ	Engine Name	Initial Version	Initial ELO	Initial Div.	thr.	proto-col	Hash Kb	EGTs	Authors	Country Codes	Final Div.
01	An	Andscacs	0.93070	3339	P	43	UCI	16,384	–	Daniel José Queraltó	AD	→ P
02	Ar	Arasan	TCEC13	3142	3	43	xboard	16,384	Syz.	Jon Dart	US	↗↘ 3
03	Bc	Bobcat	8	3072	3	43	UCI	16,384	–	Gunnar Harms	NL	↘ 4
04	Bo	Booot	6.3.1	3273	1	16	UCI	8,192	–	Alex Morozov	UA	↘ 2
05	Cb	ChessbrainVB	3.7	3242	2	43	xboard	1,200	–	Roger Zuehlsdorf	DE	↗↘ 2
06	c22	chess22k	1.1	3072	4	16	UCI	4,096	–	Sander Maassen vd Brink	NL	→ 4
07	Ch	Chiron	S13	3340	1	43	UCI	16,384	Syz.	Ubaldo Andrea Farina	IT	↗↘ 1
08	De	Deus X	1.0	3200	4	16	UCI	4,096	–	Albert Silver and the LC0 team	BR	↗ 3
09	Et	Ethereal	10.81	3176	3	43	UCI	16,384	Syz.	Andrew Grant	US	↗↗↗ P
10	Fi	Fire	7	3393	P	43	UCI	16,384	Syz.	Norman Schmidt	US	→ P
11	Fz	Fizbo	1	3284	1	43	UCI	16,384	Syz.	Youri Matiounine	US	→ 1
12	Fr	Fritz	16.10	3165	1	43	UCI	16,384	Nal?	Vasik Rajlich	CZ/US	→ 1
13	Gi	Ginkgo	2.012	3267	P	43	UCI	16,384	–	Frank Schneider	DE	↘ 1
14	Gu	Gull	180521	3217	2	43	UCI	16,384	Syz.	Vadim Demichev	RU	→ 2
15	Ha	Hannibal	2E+07	3193	3	43	UCI	16,384	–	Sam Hamilton, Edsel Apostol	US/PH	→ 3
16	Ho	Houdini	6.03	3491	P	43	UCI	16,384	Syz.	Robert Houdart	BE	→ P
17	Iv	Ivanhoe	999946h	3116	4	43	UCI	16,384	Robbo3	Golyadkin, Igoronov et al	–	↘ –
18	Jo	Jonny	8.1	3252	1	43	UCI	16,384	Syz.	Johannes Zwanzger	DE	→ 1
19	Ko	Komodo	12	3466	P	43	UCI	16,384	Syz.	Don Dailey, Larry Kaufman, Mark Lefler	US	→ P
20	La	Laser	180818	3194	1	43	UCI	16,384	Syz.	Jeffrey An, Michael An	US	→ 1
21	Lc	LCZero	16.1016	3219	4	–	UCI	–	–	UCT/NN AI Community	–	↗ 3
22	Ne	Nemorino	5.01	3104	3	43	UCI	16,384	Syz.	Christian Günther	US	↘ 4
23	Ni	Nirvana	2.4	3168	2	16	UCI	8,192	–	Thomas Kolarik	US	→ 2
24	Pe	Pedone	1.8	3104	3	43	UCI	8,192	Syz.	Fabio Gobbato	IT	→ 3
25	Ro	Rodent III	0.258	3030	4	16	UCI	4,096	–	Pawel Koziol	PL	→ 4
26	Se	Senpai	2.0	3062	4	16	UCI	16,384	–	Fabien Letouzey	FR	→ 4
27	St	Stockfish	160518	3554	P	43	UCI	16,384	Syz.	Tord Romstad, Marco Costalba, Joona Kiiski, Gary Linscott	NO/IT/FI/CA	→ P
28	Te	Texel	1.08a11	3273	2	43	UCI	16,384	Syz.	Peter Österlund	SE	→ 2
29	Tu	Tucano	7.05	2919	4	43	xboard	1,024	–	Alcides Schulz	BR	↘ –
30	Va	Vajolet2	2.6	3119	2	43	UCI	16,384	Syz.	Marco Belli	IT	↘ 3
31	Wa	Wasp	3.2	2964	4	43	UCI	8,192	—	John Stanback	US	→ 4
32	Xi	Xiphos	0.3.14	3193	2	43	UCI	16384	—	Milos Tatarevic	RS	→ 2

Table 2. The TCEC13 Division 4 cross-table: two DRR phases, 28 rounds, 112 games.

#	Engine	ELO	Pts	P%	Elo ±	SB	nSB	Lc	De	Wa	Ro	Se	c22	Tu	Iv
1	LCZero 16.10161	3219	20.0	71.4	-9	251.25	62.81		1=0=	0=1=	1=1=	111=	11=1	==11	==11
2	DeusX 1.0	3200	18.5	66.1	-40	229.75	57.44	0=1=		001=	====	===1	111=	1110	1111
3	Wasp 3.2	2964	18.0	64.3	222	236.25	59.06	1=0=	110=		=111	==1=	=0==	1==1	1==1
4	Rodent III 0.258	3030	12.5	44.6	-14	161.25	40.31	0=0=	====	=000		====	=0==	1101	==1=
5	Senpai 2.0	3062	12.5	44.6	-13	160.50	40.13	000=	===0	==0=	====		====	1===	01=1
6	chess22k 1.10	3072	11.0	39.3	-60	149.75	37.44	00=0	000=	=1==	=1==	====		1=00	===0
7	Tucano 7.05	2919	10.0	35.7	68	134.25	33.56	==00	0001	0==0	0010	0===	0=11		====
8	Ivanhoe 999946h	3116	9.5	33.9	-153	123.00	30.75	==00	0000	0==0	==00	10=0	===1	====	

1 Division 4: 2 DRR phases, 28 rounds, 112 games, tempo 30′+10″/m

As for TCEC12, each engine played both White and Black from 14 defined four-ply openings. The results are as in Table 2: ‘P%’ is the %-score and ‘ELO±’ is the change to the engine’s nominal ELO based on its performance. ‘nSB’ is the Sonnerborn-Berger score, normalised as for one double round-robin.

Online interest naturally focused on the new 'NN approach' engines LC0 and DEUS X (Silver, 2018), DEUS X being powered and trained by LC0 software. It is however trained from human games rather than from zero which is the convention for training ALPHAZERO and LC0. As seen in the results of Table 2, and surprising to those not actually involved, LC0 justified its 'wild card' invitation with a comfortable win and DEUS X was the runner-up on debut and in its very first version.

2 Division 3: two DRR phases, 14 rounds, 112 games, tempo 30′+10″/m

Table 3. The TCEC13 Division 3 cross-table: two DRR phases, 28 rounds, 112 games.

#	Engine	ELO	Pts	P%	Elo ±	SB	nSB	Et	Ar	Lc	Pe	De	Ne	Ha	Bo
1	Ethereal 10.81	3176	22.5	80.4	236	281.50	70.38		1=11	1===	===1	1==1	1111	11=1	111=
2	Arasan TCEC13	3142	16.0	57.1	77	196.00	49.00	0=00		==1=	==10	01=1	1=1=	===1	1==1
3	LCZero 16.10520	3219	16.0	57.1	-33	204.00	51.00	0===	==0=		==1=	==1=	=011	===1	1==1
4	Pedone 1.8	3104	15.0	53.6	100	186.75	46.69	===0	==01	==0=		1000	0===	1111	=111
5	DeusX 1.0	3200	13.5	48.2	-86	169.00	42.25	0==0	10=0	==0=	0111		=10=	==00	1=11
6	Nemorino 5.01	3104	12.0	42.9	4	143.50	35.88	0000	0=0=	=100	1===	=01=		1=0=	0111
7	Hannibal 20180806	3193	12.0	42.9	-124	141.25	35.31	00=0	===0	===0	0000	==11	0=1=		11=1
8	Bobcat 8	3072	5.0	17.9	-175	75.50	18.88	000=	0==0	0==0	=000	0=00	1000	00=0	

Again, the eight engines involved played both sides of 14 prescribed four-ply openings. LC0 upgraded to a new version. 13 games were won 'below the diagonal' including NEMORINO-LC0 g11.1/45.

ETHEREAL (Grant, 2018) was way out on its own. LC0 and ARASAN were 6.5 points behind, ARASAN progressing courtesy of the one win between them, g19.1/73. The key error was **29. … Bg4??** which missed **30. c6+ Ka7 31. Rd3 Rxd5 32. Nxd5 Qxb2 33. Ne3 Qc1+ 34. Nd1 Qc2 35. Nf2**. LC0 and DEUS X, the latter some 2.5 points behind LC0, were in fact frustrated by overheating in the GPU hardware which therefore had to be throttled back. First impressions are that LC0 and DEUS X play in a more human way, being relatively strong on strategy like ALPHAZERO but weaker on tactics. NEMORINO rather than HANNIBAL was demoted as it crashed twice, one being against ARASAN.

3 Division 2: two DRR phases, 14 rounds, 112 games, tempo 30′+10″/m

Table 4. The TCEC13 Division 2 cross-table: two DRR phases, 28 rounds, 112 games.

#	Engine	ELO	Pts	P%	Elo ±	SB	nSB	Et	Cb	Xi	Te	Gu	Ni	Ar	Va
1	Ethereal 10.85	3379	19.5	69.6	-23	257.00	64.25		==1=	==11	1=1=	==11	==1=	==1=	1==1
2	ChessBrainVB 3.70	3242	18.0	64.3	111	229.00	57.25	==0=		=0==	=1==	=1=1	=11=	1=1=	111=
3	Xiphos 0.3.14	3193	15.0	53.6	84	199.25	49.81	==00	=1==		=0==	====	=0==	=111	=1=1
4	Texel 1.08a11	3273	13.5	48.2	-76	181.50	45.38	0=0=	=0==	=1==		====	1==0	====	=011
5	Gull 180521	3217	12.0	42.9	-45	162.50	40.63	==00	=0=0	====	====		=1==	0===	====
6	Nirvana 2.4	3168	11.5	41.1	7	163.75	40.94	==0=	=00=	=1==	0==1	=0==		0==1	=0=0
7	Arasan TCEC13	3255	11.5	41.1	-115	156.75	39.19	==0=	0=0=	=000	====	1===	1==0		====
8	Vajolet2 2.6	3119	11.0	39.3	57	145.25	36.31	0==0	000=	=0=0	=100	====	=1=1	====	

Only nine of the 40 wins are below the diagonal in the cross-table of Table 4. ETHEREAL and CHESSBRAINVB quickly distanced the rest of the field and finished three points clear of XIPHOS, an engine that double-promoted from Division 4 in TCEC12. ETHEREAL won, adding another 28 games without defeat. In game 19.2/74, ETHEREAL reached an adjudicated KRKRPP mate in 42 moves against

XIPHOS. There is always a question of what contribution the sub-7-man EGTs make. Here, XIPHOS was not using the Syzygy 6-man EGTs (de Man, 2018) while ETHEREAL was in the end consulting them more than 10 million times per move.

VAJOLET cut back on threads and power after two disconnects. ARASAN had one less win than NIRVANA and so was this time on the wrong end of the third tie-break.

4 Division 1: two DRR phases, 28 rounds, 112 games, tempo 60′+10″/m

Eight wins went to engines relatively lower in the final ranking, see Table 5, most notably g7.2/26 LASER's defeat of CHIRON (a wild finale of 30 moves and two Q-sacrifices) and CHESSBRAINVB's two wins over FRITZ, g6.2/22 and g20.2/78.

Other notable games included g1.3/3 CHIRON-FRITZ, EGT-adjudicated as a 61m mate after 83 moves: in fact, it had been a 7-man 46m mate after 72 moves but the shortest route to goal is not usually the one most easily traversed. BOOOT sadly got off on the wrong foot with disconnects in games 2.2 and 4.3. ETHEREAL playing Black swiftly demolished FRITZ in g7.3/27 and JONNY in g8.2/30. In g9.4/36, ETHEREAL demonstrated the value of the EGTs in beating CHESSBRAINVB after reaching a KRPKNP endgame with mate in 37 moves: ETHEREAL consulted the EGT over 100m times on move 50w.

Table 5. The TCEC13 Division 1 cross-table: two DRR phases, 28 rounds, 112 games.

#	Engine	ELO	Pts	P%	Elo ±	SB	nSB	Et	Ci	Fi	Fr	Jo	La	Bo	Ch
1	Ethereal 10.85	3341	19.5	69.6	99	251.75	62.94		0=1=	==1=	1=11	11==	=11=	====	11=1
2	Chiron S13	3340	18.5	66.1	69	242.00	60.50	1=0=		===1	1=01	111=	0==1	=1=1	=11=
3	Fizbo 2	3284	14.0	50.0	5	188.50	47.13	==0=	===0		==10	====	1===	====	===1
4	Fritz 16.10	3294	12.5	44.6	-57	167.75	41.94	0=00	0=10	==01		1===	====	1=1=	0=0=
5	Jonny 8.1	3274	12.5	44.6	-28	162.50	40.63	00==	000=	====	0===		==1=	====	1=1=
6	Laser 180818	3194	12.0	42.9	69	167.25	41.81	=00=	1==0	0===	====	==0=		====	=01=
7	Booot 6.3.1	3273	12.0	42.9	-43	169.00	42.25	====	=0=0	====	0=0=	====	====		0==1
8	ChessBrainVB 3.70	3300	11.0	39.3	-114	147.25	36.81	00=0	=00=	===0	1=1=	0=0=	=10=	1==0	

ETHEREAL and CHIRON had established their claims to the top spots on the podium with the first round-robin. They extended away with FIZBO a distant third. ETHEREAL has just one loss, to CHIRON, in its last 84 games and has uniquely promoted three times this season. It won both sides of an opening on CHESSBRAINVB, JONNY and FRITZ here. CHESSBRAINVB mysteriously worsened with each round-robin and returned to Division 2 after being third at the mid-point. The two early crashes by BOOOT led to its downfall and saved LASER from the same fate. Given that crashes are so disappointing for the online audience, TCEC could usefully pull together the known intelligence on how to avoid them.

5 Division P, four DRR phases, 56 rounds, 224 games, tempo 90′+10″/m

ANDSCACS, ETHEREAL, GINKGO, KOMODO and STOCKFISH updated for this season whereas CHIRON, FIRE and HOUDINI did not. A key question was whether CHIRON and ETHEREAL would stay in the top division after their promotions. The mandated openings from the second author here specified the first eight moves.

After the first round-robin, STOCKFISH led KOMODO with ANDSCACS, ETHEREAL and HOUDINI contesting third place. After colour-switching the engines in the second round-robin to level the playing field, a clearer potential podium suggested itself: STOCKFISH, HOUDINI, KOMODO, FIRE in equidistant

line astern with ETHEREAL just fifth. However, a presumably updated ETHEREAL might fare better in TCEC Cup 1 (Haworth and Hernandez, 2019c), an interlude following this division. After the first quarter, where one might claim to be half-informed statistically, GINKGO and CHIRON were occupying the relegation zone. The matches STOCKFISH–ANDSCACS and KOMODO–GINKGO were 2-0 wins for the first-named engine.

At the half-way point, STOCKFISH had pulled 3½ points clear of HOUDINI, courtesy of two relatively successful results, 4-0 v ANDSCACS and 3½-½ v ETHEREAL. Both leaders remained unbeaten and had scored 3-1 against KOMODO which was clear 3rd. FIRE was a lonely 4th: the top half of Division P seems to be unchallenged and perhaps sequenced. ETHEREAL just edged 5th on number of wins but was only 1½ points clear of tail-ender GINKGO.

The third DRR saw KOMODO wake up, breathing fire. It inflicted a first loss on STOCKFISH and its third on FIRE and ETHEREAL: it sustained no losses itself. It finally overhauled the still unbeaten but win-shy HOUDINI with scores of 4½/7 in RR5 and 5½/7 in RR6. Would KOMODO continue in this vein: would HOUDINI's +2 against Komodo save it in a tiebreak? Who would ultimately join STOCKFISH in the Superfinal? In RR8, g50.4/200, KOMODO beat STOCKFISH and two games later, STOCKFISH beat HOUDINI: the first game had plenty of play left after 73 moves but the second was a clearer and quicker win from an advantageous opening.

The division was marked by relatively few wins for Black, the long g14/4.2 FIRE-KOMODO battle being of particular interest. Perhaps the only two notable 'underdog wins' below the cross-table diagonal of Table 6 were by the demoted engines against ETHEREAL (games 25.4/100 and 52.1/209) which was only three points above demotion itself.

Table 6. The TCEC14 Premier Division cross-table: four DRR phases, 56 rounds.

#	Engine	ELO	Pts	P%	Elo ±	St	Ko	Ho	Fi	Et	An	Gi	Ch
1	Stockfish 010918	3519	39.0	69.6	45		1=1==010	=======1	====1=1=	1=11==1=	1111=1=1	=11=1=1=	=111=1==
2	Komodo 2121.01	3475	36.0	64.3	66	0=0==101		=0=0==1=	1==1=1==	=1=1=1=1	====1=1=	111==111	==1=1=1=
3	Houdini 6.03	3491	33.0	58.9	-73	=======0	=1=1==0=		====1===	========	=1===1=1	=1=1====	=1=1==11
4	Fire 7.1	3393	27.0	48.2	8	====0=0=	0==0=0==	====0===		01==0==1	========	===1====	1====11=
5	Ethereal 10.97	3350	24.0	42.9	33	0=00==0=	=0=0=0=0	========	10==1==0		01=====1	=======0	1==0====
6	Andscacs 094030	3339	22.5	40.2	15	0000=0=0	====0=0=	=0===0=0	========	10=====0		========	=======1
7	Ginkgo S13	3340	21.5	38.4	-20	=00=0=0=	000==000	=0=0====	===0====	=======1	========		======0=
8	Chiron S13	3354	21.0	37.5	-74	=000=0==	==0=0=0=	=0=0==00	0====00=	0==1====	=======0	======1=	

Table 7. The Premier Division head-to-head and per-round-robin results: four DRR phases, 56 rounds.

#	Engine	ELO	Pts	SB	nSB	St	Ko	Ho	Fi	Et	An	Gi	Ch	RR	1	2	3	4	5	6	7	8
1	Stockfish 010918	3519	39.0	1002.00	62.63		4½	4½	5	6	7	6	6		5	5	6	5	4½	4	5½	4
2	Komodo 2121.01	3475	36.0	923.00	57.69	3½		3½	5½	6	5	7	5½		4	4	4	4	4½	5½	5	5
3	Houdini 6.03	3491	33.0	873.25	54.58	3½	4½		4½	4	5½	5	6		3½	5½	3½	5	4	4	3½	4
4	Fire 7.1	3393	27.0	720.75	45.05	3	2½	3½		4	4	4½	5½		3	4	3½	3½	2	3½	3½	4
5	Ethereal 10.97	3350	24.0	650.50	40.66	2	2	4	4		4½	3½	4		3½	3	3	2	4	3	3	2½
6	Andscacs 094030	3339	22.5	602.00	37.63	1	3	2½	4	3½		4	4½		3½	2	3	3	3	2½	3	2½
7	Ginkgo S13	3340	21.5	579.00	36.19	2	1	3	3½	4½	4		3½		3	2	2½	2½	3	3	2	3½
8	Chiron S13	3354	21.0	573.00	35.81	2	2½	2	2½	4	3½	4½			2½	2½	2½	3	3	2½	2½	2½

6 The TCEC13 Superfinal match: 100 games, tempo 120′+15″/m

This season, TCEC introduced a change of mode between Division P and the Superfinal. This was the 'TCEC Cup', a knockout tournament involving all the TCEC 13 engines. It was an excellent innovation

which will no doubt be repeated. The authors here report on its thirty-one matches separately (Haworth and Hernandez, 2019c).

Jeroen Noomen (2018) had adjusted his approach to choosing superfinal openings. His comments reveal how much thought goes into this aspect of TCEC. The 50 openings split across the ECO A/B/C/D/E range 13/12/12/6/7, the D/E lines being considered "too easy for top engines". The openings aimed to leave a position with an advantage in the range [0.2, 0.55] and, despite the excellence of the engines, a win-rate of 20% was expected with 25% as target.

Once again, Jeroen made target. The win-rate was 22%, STOCKFISH winning 16 to KOMODO's 6. STOCKFISH had two wins with Black to KOMODO's one and there was only one game-pair, games 85-86, where both sides won. Thus, the final score was 55-45, see Table 8, a performance that would suggest an ELO difference of only 36. In fact, although KOMODO lost the match, it did marginally better than might have been expected.

Wool (2018) provides an admirably generous and informative commentary on the games, covering the wins of course but also showing the struggle inherent in the many draws.

Table 8. The TCEC 13 Superfinal match of 100 games: the decisive games, Black wins underlined.

Superfinal	**ELO**	**Score**	**Perf.**	**ELO Δ**	**# of**	**games won** (0-1 wins underlined)	**# of**	**game-pairs won**	**win-pairs**
STOCKFISH 18102108	3519	+16 =78 -6	55%	36	16	1, 5, 17, 29, 41, 53, 56, 59, 71, 77, 79, 85, 91, 93, 95, 98	15	1, 3, 9, 15, 21, 27, 28, 30, 36, 39, 40, 46, 47, g85-86	(1-0/1-0)
KOMODO 2155.00	3475	+6 =78 -16	45%		6	36, 44, 74, 75, 86, 88	5	18, 22, 37, 38, 44	

Summary

The two innovative engines exploiting neural-network architecture progressed to Division 3 with LC0 nearly promoting again to Division 2. Shall we see one of them passing through Division 2 next season?! TCEC are to be congratulated for taking on the cost, risk and controversy of including GPUs to facilitate these exciting NN developments. They are now being rewarded by positive momentum and results from these new engines. No doubt the overheating and reliability problems will be addressed and solved. Another highlight was ETHEREAL's progression from Division 3 to Division P where it still gained ELO points despite shipping several losses.

The TCEC exploration of chess openings by the second author here and by Jeroen Noomen has been treated above. Terminations by the 50-move rule and 'EGT wins' are very rare as the engines anticipate these endings and evaluate accordingly.

Table 9. The shortest and longest 1-0, drawn and 0-1 games in each phase of TCEC13.

	1-0						**½-½**						**0-1**					
	Shortest			**Longest**			**Shortest**			**Longest**			**Shortest**			**Longest**		
Div.	**Game**		**#mv**	**Game**		**#mv**	**Game**		**#mv**	**Game**		**#mv**	**Game**		**#mv**	**Game**		**#mv**
4	15.4/60	Lc-Ro	31	25.2/98	Ro-Tu	119	5.3/19	Ro-c22	26	27.3/107	Fr-Sc	272	5.1/17	Iv-Wa	34	7.1/25	Lc-Wa	116
3	27.4/108	Pe-Ar	23	3.1/9	Et-Lc	96	7.4/28	De-Ha	22	24.1/93	Lc-Et	176	5.3/19	Bo-Ha	30	21.3/83	Ne-Et	122
2	15.2/58	Et-Te	40	1.3/3	Ar-Gu	143	10.1/37	Ni-Et	14	27.3/107	Cb-Et	173	27.1/105	Te-Ni	42	6.1/21	Ni-Te	165
1	20.3/79	Et-La	38	5.4/20	Fr-Jo	106	21.1/81	Bo-Fi	17	4.2/14	Jo-La	157	7.3/27	Fr-Et	41	22.3/87	Fr-Ch	127
P	10.4/40	Ho-Ko	36	25.4/100	Ch-Et	149	8.1/29	Gi-An	17	7.2/26	Ko-Ch	217	26.2/102	Et-St	56	4.2/14	Fi-Ko	126
F	41	St-Ko	44	17	St-Ko	68	38	Ko-St	28	6	Ko-St	197	75	St-Ko	51	98	Ko-St	82
O'all	3, 27.4	Pe-Ar	23	P, 25.4	Ch-Et	149	2, 10.1	Ni-Et	14	4, 27.3	Fr-Sc	272	3, 5.3	Bo-Ha	30	2, 6.1	Ni-Te	165

Assaf Wool (2018), as mentioned above, continues to provide his usual statistics and perspective on the TCEC tournaments, picking out his own favourite games for each round robin. This is very much to be applauded. 'GM TheChesspuzzler' (2018) set up further playlists on YouTube. Kingscrusher (2018) is also commenting on TCEC and particularly LC0 in his comprehensive YouTube presence, 5000 videos and counting.

The pgn and logfiles for TCEC13, together with some chess and statistical analysis as in Table 10, are available (Haworth and Hernandez, 2019b) for further study. Some of the decisive games have had an exemplar playout added as a variation. Whether you are looking for opening novelties or subtle endgames, the longest, most balanced or the shortest, most dramatic battles, see Table 9, there is plenty of interest here, plenty of occasion for reflection. Feedback to the authors is most welcome.

Table 10. Generic statistics for each phase of TCEC13: results, terminations and average game-length.

	TCEC 13	Division 4		Division 3		Division 2		Division 1		Division P		Superfinal		Overall	
		#	%	#	%	#	%	#	%	#	%	#	%	#	%
	# games	112		112		112		112		224		100		772	
Results	Draw	58	51.8	49	42.9	72	64.3	70	62.5	151	67.4	78	78.0	478	61.9
	Wins	54	48.2	63	57.1	40	35.7	42	37.5	73	32.6	22	22.0	294	38.1
	1-0	32	28.6	42	40.2	26	23.2	28	25.0	62	27.7	19	19.0	209	27.1
	0-1	22	19.6	21	17.0	14	12.5	14	12.5	11	4.9	3	3.0	85	11.0
	White Perf.	61.0	54.5	66.5	59.4	62.0	55.4	63.0	56.3	137.5	61.4	58.0	58.0	448.0	58.0
	Black Perf.	51.0	45.5	45.5	40.6	50.0	44.6	49.0	43.8	86.5	38.6	42.0	42.0	324.0	42.0
Terminations	TCEC draw	24	21.4	19	17.0	33	29.5	38	33.9	80	35.7	52	52.0	246	31.9
	3x repetition	18	16.1	9	8.0	17	15.2	17	15.2	30	13.4	8	8.0	99	12.8
	50-move rule	5	4.5	2	1.8	2	1.8	0	0.0	4	1.8	3	3.0	16	2.1
	EGT adj., 'draw'	11	9.8	20	17.9	22	19.6	19	17.0	37	16.5	15	15.0	124	16.1
	EGT adj.	15	13.4	24	21.4	25	22.3	27	24.1	38	17.0	15	15.0	144	18.7
	TCEC win	50	44.6	54	48.2	32	28.6	28	25.0	72	32.1	22	22.0	258	33.4
	EGT adj., 'win'	4	3.6	4	3.6	3	2.7	8	7.1	1	0.4	0	0.0	20	2.6
	Tech. default	0	0.0	3	2.7	3	2.7	2	1.8	0	0.0	0	0.0	8	1.0
	Manual adj., 'win'	0	0.0	1	0.9	0	0.0	0	0.0	0	0.0	0	0.0	1	0.1
	Mate	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Length	Moves	76.7		66.5		66.0		61.1		67.5		66.5		67.4	
	Time Budget (h)	1.36		1.37		1.37		2.34		3.37		4.55		2.50	
	Time Spent (h)	1.17	86.1	1.12	81.8	1.11	81.2	2.04	87.2	2.54	75.4	3.86	84.9	2.03	81.2

REFERENCES

CPW (2018). https://tinyurl.com/icga046. The new Chess Programming Wiki website, including biographies of engines, authors and developers.

de Man, R. (2018). http://tablebase.sesse.net/syzygy/. Site providing sub-8-man DTZ_{50}'' EGTs.

'GM Thechesspuzzler' (2018). https://tinyurl.com/gmtcp-pl. TCEC 13 Divisions 4/3/1/P and Superfinal video-commentary playlists.

Grant, A. (2018). https://youtu.be/1rUnk39K2FM. Nelson Hernandez interview with Andrew Grant, author of ETHEREAL.

Haworth, G. McC. and Hernandez, N. (2019a). http://centaur.reading.ac.uk/76985/. TCEC12: the 12th Top Chess Engine Championship. *ICGA Journal*, Vol. 41(1), 24-30. Doi: 10.3233/ICG-190090.

Haworth, G. McC. and Hernandez, N. (2019b). http://centaur.reading.ac.uk/78820/. TCEC13: the 12th Top Chess Engine Championship. *ICGA Journal*, Vol. 41(2) 92-99. Doi: 10.3233/ICG-190103. This report as archived, together with supporting data and annotated pgn files.

Haworth, G. McC. and Hernandez, N. (2019c). http://centaur.reading.ac.uk/80284/. TCEC Cup 1. *ICGA Journal*, Vol. 41(1) 31-38. Doi: 10.3233/ICG-190099.

Intel (2017) https://tinyurl.com/icga042. Intel's specification of the XEON® E5-2699V4 processor.

Kingscrusher (2018). https://tinyurl.com/icgaj030. Video playlists for LC0, STOCKFISH etc.

Noomen, J. (2018). https://tinyurl.com/icga047. Strategy for choosing mandated openings for the TCEC13 Superfinal.

Nvidia (2018). https://www.nvidia.co.uk/geforce/products/10series/geforce-gtx-1080-ti/ GEFORCE GTX 1080 TI GPU specification and benchmark performance data.

Silver, A. (2018). https://www.youtube.com/watch?v=CpjvvcfbdR4. Nelson Hernandez interview with Albert Silver, author of DEUS X.

TCEC (2018) http://tcec.chessdom.com/archive.php Past TCEC tournaments.

Wool, A. (2018) http://mytcecexperience.blogspot.co.uk/ Assaf Wool's TCEC blog.